AIR QUALITY MONITORING CONSIDERATIONS FOR THE NORTHERN COLORADO PLATEAU NETWORK

November 2001

Introduction

The NPS Air Resources Division (ARD) has contracted with the University of Denver (DU) to produce GIS-based maps that estimate baseline values (with confidence limits) for a set of air quality parameters for all Inventory and Monitoring parks in the U.S. This information will be available in early FY 2002. ARD used preliminary DU products to help develop an implementation strategy for expanding NPS air quality monitoring under the Natural Resources Challenge. Based on the implementation strategy, ARD intends to install a continuous ozone monitor at Zion National Park (NP) in FY 2002, and potentially, at Black Canyon of the Gunnison NP in FY 2003. The air monitoring implementation strategy will be revisited in FY 2004 if additional funding becomes available. The Northern Colorado Plateau Network can use the final DU products (which will be sent to you when available), along with on-site and/or nearby off-site ambient monitoring and natural resource data discussed in this report, to help assess air quality-related conditions and monitoring needs in Network parks.

Wet Deposition

All of the NPS units in the Northern Colorado Plateau Network have a National Atmospheric Deposition Program/National Trends Network (NADP/NTN) wet deposition monitor on-site or within 115 km (about 70 miles). NADP/NTN collects data on both pollutant deposition (in kilograms per hectare per year) and pollutant concentration (in microequivalents per liter). Deposition varies with the amount of annual on-site precipitation, and is useful because it gives an indication of the total annual pollutant loading at the site. Concentration is independent of precipitation amount, therefore, it provides a better indication of whether ambient pollutant levels are increasing or decreasing over the years. In general, wet deposition and concentration of sulfate, nitrate, and ammonium are low in the western U.S. relative to the Midwest and East. Pollutant deposition in the Northern Colorado Plateau region is consistent with this pattern; however, wet sulfate concentrations in the region are higher than those at most western NADP/NTN sites, and wet nitrate and ammonium concentrations are almost as high as those at NADP/NTN sites in the eastern and Midwest U.S. (see U.S. wet deposition isopleth maps at http://nadp.sws.uiuc.edu). Data from the NADP/NTN sites in the Northern Colorado Plateau region are summarized below.

Bryce Canyon NP

The Bryce Canyon NP NADP/NTN site (site #UT99) has been in operation since 1985. The site data show a decrease in concentration of wet sulfate, no apparent trend in concentration of wet nitrate or ammonium, an increase in deposition of wet nitrate and ammonium, and no apparent trend in wet sulfate deposition.

Canyonlands NP

The NADP/NTN site was installed at Canyonlands NP (site #UT09) in 1997. Sufficient data are not yet available to perform a trend analysis for this site.

Gothic, CO

An NADP/NTN site was installed at Gothic, Colorado, (site #CO10) in1999. Sufficient data are not yet available to characterize pollutant trends at the site.

Grand Canyon NP

The NADP/NTN site at Grand Canyon NP (site #AZ03) has been operating since 1981. A review of site data shows concentration and deposition of wet sulfate have decreased. Wet deposition of ammonium and nitrate shows no overall trend, but there has been a slight increase in concentrations of both pollutants.

Green River, UT

The Green River, Utah, NADP/NTN site (site #UT98) has been in operation since 1985. While there has been a slight decrease in wet sulfate concentration, there has been no apparent trend in wet sulfate deposition, or in wet nitrate or ammonium concentration or deposition, at the site.

Logan, UT

An NADP/NTN site has been operating at Logan, Utah, (site #UT01) since 1983. There has been no apparent trend in concentration or deposition of wet sulfate, nitrate, or ammonium at this site.

Mesa Verde NP

The Mesa Verde NP NADP/NTN site (site #CO99) has been in operation since 1981. The site data show a decrease in concentration of wet sulfate, increase in concentration of wet nitrate and ammonium, decrease in wet sulfate deposition, and no apparent trend in wet nitrate and ammonium deposition.

Molas Pass, CO

The Molas Pass NADP/NTN site (site #CO96) has been operating since 1986. The data show a decrease in wet sulfate concentration and deposition. There has been no apparent trend in wet ammonium deposition, but wet ammonium concentration has decreased. Wet nitrate deposition has increased, but there has been no apparent trend in wet nitrate concentration.

Murphy Ridge, UT

Murphy Ridge, Utah, (site #UT08) has had a NADP/NTN site since 1986. The site is operated by Amoco, Incorporated, in Rich County, and the location of the monitor is unclear. Site data show that while the concentration of ammonium has decreased, there has been no apparent trend in the deposition of ammonium, or in the concentration or deposition of sulfate or nitrate.

Pinedale, WY

An NADP/NTN site has been operating in Pinedale, Wyoming (site #WY06) since 1982. A review of site data shows a decrease in wet sulfate concentration, but no apparent trend in wet sulfate deposition or in either concentration or deposition of wet nitrate or ammonium.

Sand Spring, CO

The Bureau of Land Management has been operating an NADP/NTN site in Moffat County (site #CO15) since 1979. The location of the monitor is not clear. Site data indicate both concentration and deposition of sulfate have been decreasing, but there have been no apparent trends in either concentration or deposition of either nitrate or ammonium.

Sunlight Peak, CO

The NADP/NTN site at Sunlight Peak, Colorado, (site #CO92) has been operating since 1988. Site data show a decrease in wet sulfate concentration and no apparent trends in wet sulfate deposition, wet ammonium concentration and deposition, and wet nitrate concentration and deposition.

Based solely on spatial distribution, it appears existing NADP/NTN sites provide adequate coverage for the Northern Colorado Plateau Network. Cost information is provided in case the Network is interested in installing a new site. A NADP/NTN wet deposition site costs $5,000 to $8,000 for equipment purchase and installation, and operating costs (including site operation, chemical analysis, and reporting) are about $7,000 per year.

Dry Deposition

Ten of the 16 units in the Northern Colorado Plateau Network have a Clean Air Status and Trends Network (CASTNet) dry deposition monitor on-site or within 130 km (about 80 miles). These units are Arches NP, Black Canyon of the Gunnison NP, Canyonlands NP, Capitol Reef NP, Colorado National Monument (NM), Curecanti National Recreation Area (NRA), Fossil Buttes NM, Hovenweep NM, Natural Bridges NM, and Pipe Spring NM. CASTNet uses different monitoring and reporting techniques than NADP/NTN, so the dry deposition amounts are reported as nitrogen and sulfur. In addition, because CASTNet calculates dry deposition based on measured ambient concentrations and estimated deposition velocities, there is greater uncertainty in the reported values. Due to the small number of CASTNet sites, use of dry deposition isopleth maps is not advised at this time. CASTNet data collected at the sites in the Northern Colorado Plateau region are summarized below.

Canyonlands NP

The Canyonlands NP CASTNet site (site #CAN407) has been operating since 1995. A review of the site data shows no apparent trend in dry nitrogen or sulfur deposition. Based on a comparison of CASTNet and on-site NADP/NTN data, CASTNet estimates total sulfur deposition consists of 66 percent wet deposition and 34 percent dry deposition, while total nitrogen deposition is 55 percent wet and 45 percent dry.

Gothic, CO

Gothic, Colorado, has had a CASTNet site (site #GTH161) since 1989. A review of site data shows no trends in dry sulfur or nitrogen deposition. According to CASTNet, total sulfur deposition at the site consists of 81 percent wet and 19 percent dry deposition, while total nitrogen deposition is 76 percent wet and 24 percent dry.

Grand Canyon NP

The CASTNet site at Grand Canyon NP (site #GRC474) has been operating since 1989. The site data show no apparent trend in dry nitrogen or sulfur deposition. Based on a comparison of CASTNet and on-site NADP/NTN data, CASTNet estimates total sulfur deposition is 76 percent wet and 24 percent dry, while total nitrogen deposition at Grand Canyon NP consists of 63 percent wet deposition and 37 percent dry deposition.

Great Basin NP

The CASTNet site at Great Basin NP (site #GRB411) has been operating since 1995. There are no apparent trends in dry nitrogen or sulfur deposition data from the site. Based on a comparison of CASTNet and on-site NADP/NTN data, total sulfur deposition consists of 73 percent wet deposition and 27 percent dry deposition, while total nitrogen deposition is 60 percent wet and 40 percent dry.

Mesa Verde NP

The Mesa Verde NP CASTNet site (site #MEV405) has been operating since 1995. Data show no trends in dry sulfur or nitrogen deposition at the site. Based on a comparison of CASTNet and on-site NADP/NTN data, total sulfur deposition consists of 68 percent wet deposition and 32 percent dry deposition, while total nitrogen deposition is 52 percent wet and 48 percent dry.

Pinedale, WY

The CASTNet site at Pinedale, Wyoming, (site #PND165) has been operating since 1989. Site data show no trends in dry sulfur or nitrogen deposition. Site data show total sulfur deposition consists of 60 percent wet deposition and 40 percent dry deposition, while total nitrogen deposition is 65 percent wet and 35 percent dry.

Based solely on spatial distribution of CASTNet sites, it appears that not all parks in the Northern Colorado Plateau Network have representative dry deposition data. Installing a site in southwest Utah would provide dry deposition data for Bryce Canyon NP, Cedar Breaks NM, and Zion NP. Installation and annual operating costs for a CASTNet site are about $50,000 and $15,000, respectively.

Surface Water Chemistry

The Northern Colorado Plateau Network has contracted with Colorado State University (CSU) to assess Network water quality monitoring needs. CSU should review available water quality data to help determine if any parks in the Network contain acid-sensitive surface waters. This review should evaluate the adequacy of existing data in terms of how old the data are and whether or not sampling points represent all types of surface waters, e.g., streams, lakes, potholes, that occur in the park. In general, acid-sensitive surface waters have a specific conductance below 25 microseimens per centimeter (μS/cm), a pH below 6.0 and an acid neutralizing capacity below 100 microequivalents per liter (μeq/l). If acid-sensitive surface waters occur in any Northern Colorado Plateau Network park, ARD can help Network staff determine the need for air pollution-related water quality monitoring.

Visibility

Visibility-impairing particles and certain gases are monitored in natural areas through the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. Because of the mandates of the Clean Air Act, the IMPROVE program has focused monitoring efforts in Class I air quality areas. Regardless, IMPROVE monitoring provides a regional analysis of visibility; therefore, the data indicate conditions in nearby Class II air quality areas. IMPROVE program staff recently identified an error in past data calculations, and are in the process of re-calculating the data. Therefore, trend data are not currently available for IMPROVE sites. IMPROVE monitoring occurs in, or within 130 km (80 miles) of, all but four units in the Northern Colorado Plateau Network (Dinosaur NM, Fossil Butte NM, Golden Spike National Historic Site (NHS), and Timpanogos Cave NM). Of the four sites, it is likely that visibility is an important issue only at Dinosaur NM. Therefore, Network staff may want to consider installing an IMPROVE visibility monitor at Dinosaur NM. Installation and annual operating costs of an IMPROVE site are about $15,000 and $30,000, respectively.

Ozone

Only one of the Northern Colorado Plateau Network parks currently has on-site ozone monitoring; historic data are available for Arches NP and Colorado NM. The site at Canyonlands NP (site #490370101) has been operating since 1992. If the ARD gets full FY 2002 base funding to expand the NPS air quality-monitoring network under the Natural Resources Challenge, an ozone monitor will be installed in Zion NP in FY 2002, and potentially, an ozone monitor will be installed in Black Canyon of the Gunnison NP in FY 2003. Based on a spatial assessment of existing monitors and known pollution sources, it appears that with the addition of the monitors at Zion and Black Canyon of the Gunnison NPs, all but three units in the Northern Colorado Plateau Network would have representative ozone data. The closest ozone monitors to Colorado NM, Dinosaur NM, and Fossil Butte NM are more than 90 km away and/or have intervening pollution sources. The Network may want to install an ozone monitor at Dinosaur NM, for example, to provide better data for these three parks. Installation and annual operating costs for an ozone-monitoring site are about $90,000 and $14,000, respectively. The results of the DU project will clarify how well existing monitors represent conditions in Network parks. In addition, the products will help determine whether a single monitor can adequately represent ozone conditions for a large or topographically complex park.

Vegetation

For vegetation, the focus is on ozone sensitivity because 1) ozone is a regional pollutant and is, therefore, more likely to affect park resources than either sulfur dioxide or nitrogen oxide which quickly convert to other compounds, and 2) the literature on ozone sensitivity is more recent and more reliable than that for other pollutants. Unfortunately, not much is known about the ozone sensitivity of southwestern U.S. species. Park vascular plant lists contained in a May 2001 version of NPSpecies were compared to the general ozone-sensitive plant species lists contained in the NPS Synthesis information management system (see attached Synthesis species lists). The Synthesis lists were developed by an expert in the field of ozone effects on vegetation. Note that the Synthesis lists are a general guide to ozone sensitivity. Differences in plant genetics,

weather conditions, water availability, and ozone concentrations will affect whether or not a species exhibits injury in a particular park. Ozone sensitive species were identified for all of the units in the Northern Colorado Plateau Network (see attached tables of sensitive species for Network parks).

It is generally agreed that plant foliar injury occurs after a cumulative exposure to ozone. One ozone statistic that is used to evaluate the risk of plant injury is the SUM06. SUM06 is the sum of all hourly average ozone concentrations greater than or equal to 0.06 parts per million (ppm). In 1997, a group of ozone effects experts recommended 3-month, 8:00 a.m. to 8:00 p.m., SUM06 effects endpoints for natural vegetation, *i.e*., 8 to12 ppm-hrs for foliar injury to natural ecosystems and 10 to 15 ppm-hrs for growth effects on tree seedlings in natural forest stands. The DU products will give some indication of the ozone risk to sensitive vegetation in Northern Colorado Plateau Network parks. Note that the SUM06 recommendations were based primarily on vegetation in the southeastern United States. Southeastern U.S. species typically have plenty of available soil water, so plant stomates are open for long periods--allowing for increased ozone uptake. Research suggests plants that grow in drier climates take in less ozone through their stomates, and therefore, can tolerate higher ozone exposures. If ozone concentrations indicate potential foliar injury of vegetation, Network staff may want to conduct a pilot study of foliar injury on one or two species before committing to an extensive monitoring effort.

Conclusions

All of the NPS units in the Northern Colorado Plateau Network have a NADP/NTN wet deposition monitor on-site or within 115 km.

Ten of the NPS units in the Northern Colorado Plateau Network have a CASTNet dry deposition monitor on-site or within 130 km. Installing a single site in southwest Utah would add coverage for three additional parks.

Twelve of the NPS units in the Northern Colorado Plateau Network have an IMPROVE visibility monitor on-site or within 130 km. Installing an IMPROVE monitor at Dinosaur NM may be desirable.

With the installation of ozone monitors at Zion and Black Canyon of the Gunnison NPs, 13 of the 16 NPS units in the Northern Colorado Plateau Network likely would have representative ozone data. It may be desirable to install an ozone monitor at Dinosaur NM, for example, to collect data for the remaining three parks.

Ozone sensitive species have been identified for all of the NPS units of the Northern Colorado Plateau Network. Typically, vegetation that grows in arid climates can tolerate relatively high ozone concentrations, however, limited foliar injury surveys may be warranted in Network parks.

Relevant Websites
NADP - http://nadp.sws.uiuc.edu/
CASTNet - http://www.epa.gov/castnet/
Ozone - http://www.epa.gov/airsdata/sources.htm
IMPROVE - http://vista.cira.colostate.edu/improve/
Pollution sources and air quality data - http://www.epa.gov/air/data/index.html
Ozone-specific sources and data - http://www.epa.gov/ttn/rto/areas/
Pollution source and air quality graphics - http://www.epa.gov/agweb/